Maine Marine GIS Needs Assessment

Prepared for the
Maine Department of Marine Resources

by

APPLIED GEOGRAPHICS, INC.
Empowering People with Spatial Solutions

In association with

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June, 2006

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1   Executive Summary

Maine has made a significant commitment to geographic information system GIS technology in many departments. The Maine GeoLibrary Board, the GIS Executive Council and others are working to create a more coordinated GIS system to reduce redundancies and improve data, analysis and decision-making across the state. Marine oriented organizations have much in common with more land-based programs, but they also have special needs that have not always been addressed by current efforts. The purpose of this project is to look at the current activities and needs of these organizations and recommend ways to improve development of marine GIS within state government and thereby improve coastal management.

Summary of Findings:

- A marine GIS user group should be formed to advocate strongly for the needed GIS resources of the marine community. The interviewed organizations vary in their mission and areas of interest, especially between those focused on the nearshore and offshore environments, but they have much in common and their needs are not currently being met as well as they could be.

- Marine groups should work with existing Maine GIS programs both to get better service from them and to avoid duplication of efforts. Key issues are data and metadata development and data distribution.

- Several data sets identified as needed by the marine organizations are being planned and produced by other GIS entities, including new orthophotography, parcels, watersheds and onshore hydrography. This highlights the need for marine GIS efforts to work closely with existing land-oriented GIS programs.

- Several high-demand marine data sets do not exist in GIS or are out of date. These include detailed nearshore bathymetry; benthic habitats; an update of marine geology; and human uses of the shoreline and nearshore environment. These data are expensive to produce and need a focused effort to get them developed.

- The agencies and organizations that work in the marine environment have made efforts to share data and geographic analysis on an ad hoc basis, but to date a coordinated effort has not been undertaken. Smaller organizations do not always know the data resources that are available. Better outreach and education is needed.

- Existing data is often badly documented, thereby reducing its value and making it difficult for users to find and use the data appropriately. However, at the present, it is quite difficult and time consuming to make metadata fully compliant with state and federal standards. State and federal resources and attention needs to be

focused on this issue; i.e. to assist data developers quickly and accurately create compliant and useful metadata.

- The Maine Department of Marine Resources, given adequate resources, is the state agency best positioned to take a leadership role to coordinating and advocating better marine GIS throughout Maine and the Gulf of Maine.

The marine environment is a dynamic and important part of Maine. Organizations focused on the marine environment will make better use of GIS to monitor and manage this invaluable resource if they coordinate their activities.

2 Overview of the Maine Marine GIS Needs Assessment

The unique geography and feature richness of Maine's marine environment makes gathering and analyzing good, broad based data both complex and expensive. Unique factors include its large area with often indefinite boundaries, its three dimensional nature (the marine atmosphere plus the water column plus benthic geology), its convoluted morphology caused by tides, currents, and geology, the great amount and complexity of data available to be and being collected, including time sensitive data, and the fact that this environment is largely invisible to most people, and therefore much of its thematic data sets must be gathered remotely. Additionally it is difficult to integrate and analyze data sets collected at different times and/or on base maps that have made varying interpretations of shoreline and other boundaries.

Add to this the facts that:
- the marine environment has great cultural, monetary and strategic value to its many stakeholders
- GIS is a wonderful tool to enable groups to map and analyze this region for many types of issues
- GIS technology, computer software, hardware and networks in the past few years have become cheaper, faster and much easier to use without extensive training,

and we have a situation where many groups are developing and working with GIS for a great variety of purposes.

The Maine Department of Marine Resources (DMR), the state agency directly focused on the Maine marine environment, believes that better coordination, collaboration and information sharing between key stakeholder organizations could lead to more efficient and effective coastal management. This Maine Marine GIS Needs Assessment was commissioned by DMR. It has the overall goal of improving the use and coordination of GIS to inventory, study and manage the marine resources of Maine. Numerous organizations are focused on the Maine coast and a great many are currently using GIS. However, it must be noted that several of the organizations interviewed for this study have a broader geographic interest than the Maine coast, either inland or encompassing the entire Gulf of Maine. These groups include MEGIS, MEIFW, UMO, GoMOOS. Two of the organizations (WellsNERR and SVCA) represent groups with a very focused area of interest, as often do the academic groups for their various projects.

The specific tasks of this study are to:

- develop a questionnaire and conduct detailed interviews with GIS and related staff of approximately 20 government agencies, academic groups and non-governmental organizations (NGOs) having interest in the Maine marine environment

- analyze the responses to determine the nature of each groups current GIS operations, including significant goals, applications, data and sources, budget, software and hardware

- identify the high priority GIS needs of organizations that would be most beneficial to effective coastal management

- identify bottlenecks to a more coordinated relationships between these groups including an analysis of the redundancies and gaps

- make recommendations to DMR that would address these limitations and problems in order to meet the goal of a more coordinated group of Maine marine GIS users

- estimate the costs of implementing these recommendations

2.1   Background of GIS Planning in Maine

The State of Maine has a long history of using geographic information system (GIS) technology to study and manage geographic data for a variety of state, regional and local issues. It has been estimated that over $20,000,000 has been spent on GIS in Maine since the 1980's. The Maine Legislature, in 2001, believing that more coordinated statewide GIS efforts could result in a more efficient and effective Maine GIS, set up the Resolve 23 Committee to study this issue and make recommendations. The 2002 Resolve 23 plan by this committee was called "***State of Maine GIS Needs Assessment and Requirements Analysis and Strategic Plan to Develop the Maine Public Library of Geographic Information***".

The Strategic Plan was adopted by the Legislature and its recommendations are being implemented. The Maine GeoLibrary is an established entity. The GeoLibrary has a Board of Directors with 15 members that represent stakeholders from State agencies, counties, regional councils, municipalities, public utilities, the University of Maine, environmental groups, the public, and the private sector. The Maine Office of GIS (MEGIS) within the Maine Office of Information Technology serves as technical staff.

This **Marine GIS Needs Assessment** is an effort to build upon the Resolve 23 study and its implementation to specifically focus on the needs of agencies and organizations and programs focused on the marine environment.

All of the state agencies interviewed for this study were also interviewed in the needs assessment portion of the Resolve 23 study. In addition, the Maine Audubon Society and the Island Institute were also interviewed as representative of the non-governmental organizations (NGOs). Maine Audubon has a seat on the GeoLibrary Board to represent Environmental Interests.

While the specific needs of marine GIS were not explicitly addressed in the Resolve 23 report, many of the overall recommendations now being implemented from that study will nicely support many of the identified needs from this study, and the successful and continuing implementation of statewide GIS in Maine is a key factor to help solve the bottlenecks and limitations identified by the marine GIS users.

Another innovative and relevant study is the ongoing **Maine Bay Management Study** authorized by the Maine legislature in 2004 and scheduled to conclude early in 2007. It is funded by the federal Coastal Zone Management Program and overseen by the Land and Water Resources Council. The overall goal is to develop innovative approaches managing Maine's embayments. The identification of mapping and information transfer needs is one of the main goals of the study. The GIS-related results of this study should be used to inform and prioritize future marine GIS initiatives.

The **Maine Coast Protection Initiative** (MCPI) is a collaboration between public and private conservation partners to leverage funding, technical assistance, and other resources for organizational capacity building to conserve important areas along Maine's coastal zone. They developed their program in consultation with approximately 70 organizations to increase coastal land protection. Most of these groups are local land trusts. The principal project sponsors are the Maine State Planning Office, the Maine Coast Heritage Trust, NOAA Coastal Services Center and the Land Trust Alliance.

MCPI conducted a small but interesting GIS needs assessment of the 47 Maine land trusts. They gathered and aggregated data on the experience and opinions about GIS and issued a report in May 2005. Their insights about the GIS needs of small land tructs are factored into the Recommendations section of this document.

3   The Marine GIS Questionnaire and Database

In collaboration with DMR staff, a 63 question form was developed to solicit a wide variety of answers and opinions from the participants. It was designed to be sent to the participants in advance of the actual face-to-face interview in order for the participants to be able to think about and prepare his/her answers. A copy of the questionnaire is attached as Appendix A of this report and the list of respondents is in Attachment B. The full survey responses were put into an Access database for aggregation and analysis within this report. In addition, the full database and various queries and reports is to be delivered as a part of this report to enable further analysis and future updating.

The following categories of questions were asked and answered during the survey:

Section 1: General Stakeholder Information. This includes contact information for both the individual being interviewed and his/her organization.

Section 2: Existing GIS Activities. This comprises 17 questions about the staffing, funding, data needed and produced, applications, and relations with other GIS operations and collaborative efforts.

Section 3: Technology Infrastructure. This section solicits information on the organizations GIS software, operating system(s), network and internet connectivity.

Section 4: Marine Data Sharing and Exchange. This section gets at the existing nature, both formal and informal, of what data is shared with other organizations, and what data

is received from others. It also asks what data currently unavailable is required by the organization to do a better job with marine GIS activities.

Section 5: Marine GIS Applications. This section asks what GIS applications the organization is currently involved in and what additional applications they would like to develop or use.

Section 6: Looking Forward. The final section solicits opinions on what type of GIS support would be most valuable to the organization; the interviewees perception of existing bottlenecks limiting marine GIS in Maine; and ideas for improving marine GIS in Maine.

4   The Questionnaire Responses

4.1   Stakeholder Information

The Maine Department of Marine Resources provided the list of organizations most involved in the Maine marine environment and the staff most knowledgeable about GIS issues. There are 20 organizations and a total of 26 interviewees. The Maine Office of GIS was interviewed as the lead agency for GIS in Maine. The goal was to gain the insights of a cross-section of agency and organization types including large government agencies, academic and science research organizations, land trusts and conservation groups for the purpose of gaining the widest possible representation of perspectives. One respondent from each agency responded with the exception of DMR, which had three respondents, and SPO, USM, MCHT, WellsNERR, who had two respondents each.

Organizations Interviewed - Sorted by Type		
Type	**Name**	**Acronym**
State	Maine Department of Marine Resources	DMR
State	Maine Office of GIS	MEGIS
State	Maine Department of Environmental Protection	DEP
State	Maine State Planning Office	SPO
State	Maine Department of Conservation	DOC
State	Maine Department of Inland Fisheries and Wildlife	MEIFW
Science Research	Gulf of Maine Research Institute	GMRI
Science Research	Gulf of Maine Ocean Observing System	GoMOOS
School	University of New England	UNE
School	University of Maine, Department of Geology	UMO
School	University of Maine, School of Marine Science	SMS
School	College of the Atlantic	COA
School	University of Southern Maine	USM
Land Trust	The Nature Conservancy	TNC
Land Trust	Maine Coast Heritage Trust	MCHT
Federal	U.S. Fish and Wildlife Service	USFWS
Federal	Wells National Estuarine Research Reserve	WellsNERR
Conservation Group	Maine Audubon	MA
Conservation Group	Sheepscot Valley Conservation Association	SVCA

Organizations Interviewed - Sorted by Type		
Type	**Name**	**Acronym**
Conservation Group	Island Institute	II

While these organizations vary widely in mandate, focus, thematic concerns, and geographic area of interest, they already share strong, if often informal, relations concerning GIS activities concerning particular projects. The goal for this project is that these groups can develop a more organized and overarching relationship going forward.

The survey reveals a long history of marine-related GIS operations with most of the groups interviewed. 75% have had in-house GIS for between five and 10 years, and 45% for over 10 years. The staff respondents themselves had even more experience with GIS, having a total average of over 10 years working with GIS at least part of the time at both their current organization and previous jobs. This depth of experience was similar across all organization types.

4.2   Existing Marine GIS Activity

The questionnaire in Appendix A lists all questions. The following is a summary and an aggregation of the most significant responses.

4.2.1   GIS Staff and Operations

All state and federal agencies reported operational multi-user GIS systems. Other organization self-identifications were split between multi-user systems, limited operational systems and under development, although all organizations also report providing GIS mapping to multiple users.

There is great penetration of GIS within these organizations. They report a total of 1193 professional staff. There are 154 active GIS users within this staff, or about 13 percent. In addition, these GIS staff serve 164 other staff regularly and intermittently serve an additional 171, for a total GIS-served population of 489, or 41% of the overall professional staff of these organizations.

These percentages are generally similar for all types of organizations interviewed. In addition to in-house GIS services, several organizations have active GIS web applications that serve GIS data and maps to an outside user community. These facts establish that GIS has become a significant part of core operations in these organizations and that professionals and the public are currently being served by GIS.

4.2.2   Existing Budget and Expenditures

Only 12 of the 20 respondent organizations identified a yearly budget for GIS. The total identified GIS budgets for these organizations totaled $1,582,500. It must be noted that all of these funds are not devoted to marine GIS related activities, especially the MEGIS and MEIFW budgets.

Identified GIS Budgets

Agency	GIS_budget
University of Maine, School of Marine Science	$400,000
Maine Office of GIS	$350,000
Maine Department of Inland Fisheries and Wildlife	$285,000
University of New England	$105,500
University of Maine, Department of Geology	$100,000
College of the Atlantic	$80,000
U.S. Fish and Wildlife Service	$80,000
Gulf of Maine Research Institute	$60,000
The Nature Conservancy	$60,000
Wells National Estuarine Research Reserve	$30,000
Maine Audubon	$20,000
Sheepscot Valley Conservation Association	$12,000

4.2.3 Focus of Expenditures

The questionnaire attempted to derive the percentages of GIS budgets devoted to various aspects of GIS costs- software, hardware, operations, data development, staff and application development. However very few organizations broke out these numbers in their responses, so an overview of this situation is not possible. It is possible to say that most respondents to this question described most of their expenditures as operational and only two respondents (both universities) described any expenditure as application development.

Since the principal purpose of GIS is to enable analysis and decision making based on good data, the overall trend in GIS should be towards more analysis. The fact that this is not evident in this user population is an indication that marine GIS in Maine is not yet in a mature state. However, Section 4.5 shows the extent of GIS applications currently underway. The fact that respondents had a difficult time breaking out these numbers is perhaps a further indication that GIS has become a normal part of operations in these organizations.

4.3 Technology Infrastructure

4.3.1 Software-

All organizations but two identified ESRI ArcGIS software products the main GIS software in general use. The two others were GoMOOS which used open-source MapServer software, and the University of Maine School of Marine Science, which uses

IDL, a data visualization and analysis software package. The University of New England uses both ESRI and ERDAS software. Most organizations use the Windows operating system. Three use Windows and LINUX, and GoMOOS uses FreeBSD.

4.3.2 Internet access

All organizations are connected to the internet, and all but three have high-speed connections of T1 or T3 level. SVCA has a DSL connection and the USFWS and Maine Audubon have commercial cable connections. Overall the interviewed organizations are very well set up for internet communications including GIS data transfer and GIS internet application access.

4.3.3 Existing GIS Data

The 20 organizations interviewed currently use a great number of data sets in their operations. A total of 153 unique data sets were reported to be in use. These data sets come from over 35 different sources. Included are 20 different base map data sets and an additional 8 that are boundary files. By and large the most used base map used for general purpose mapping applications are those provided by MEGIS, including the digital 1:24,000 USGS data with its coastline and orthophotography where it is available.

GIS Data Sets in Use	
Data Type	Number of Data Sets in Use
Base Map	20
Boundaries	8
Fauna	21
Fisheries	30
Flora	7
Geology	19
Infrastructure	5
Regulatory	6
Remote Sensing	4
Synthesis	14
Water Quality	19
TOTAL	153

The following chart shows the great wealth and variety of mainly thematic marine-related data sets that the interviewed organizations develop and maintain. Many of the data sets of other organizations are available to research, view and download via the MEGIS online data catalog and related web viewers http://apollo.ogis.state.me.us/catalog/. Currently there are 137 data seta available via this service, including many marine related ones. This is the main way that state agencies make their GIS data sets available to other organizations and the public.

Sources of Data Sets in Use

Source Organization	Number of Data Sets Produced and/or Maintained
DMR	49
MGS	8
USFWS	8
MDIFW	7
DEP	6
NOAA	4
MEGIS	3
WellsNERR	2
NMFS	2
GoMOOS	2
DMR/MADMF	2
UNE	2
COA	2
USGS/WHOI	2
GMRI	2
DMR & Island Institute	1
COA and Land Trusts	1
II	1
Maine Audubon & MNAP	1
MCHT	1
MDIFW & MNAP	1
MDIFW & USFWS	1
MEGIS/UMO	1
MNAP & MDIFW	1
NASA	1
NMFS/ NOAA	1
NOAA?	1
SPO	1
TNC	1
TNC/Suffolk Univ	1
UMO	1
UMO/MGS	1
USGS/Mass CZM/UMO	1
MEGIS / Specific Organization	1
Unidentified Source	**32**

It is very positive that so many organizations are taking the initiative to produce GIS data sets. However, this heterogeneous production environment makes it vital to follow good production and metadata standards. Unfortunately many of the data sets do not have adequate metadata to allow others to use them effectively and efficiently. Some users are not even sure of the source agency of some of the data sets they are using. This is

symptomatic of a situation where GIS data is exchanged informally without adequate metadata.

4.4 Current Marine Data Sharing and Exchange Initiatives

All interviewed organizations except two of the conservation groups provide GIS data sets to other organizations on at least an intermittent basis. When asked about the nature of data exchange agreements with other organizations, nine of the 20 organizations report formal or semi-formal data exchange agreements with other institutions. The others are very informal and seem to be generally ad hoc agreements.

4.4.1 Data Sharing Agreements

The following chart summarizes the responses to the request to "describe your formal agreements for data exchange":

Current Marine Data Sharing Agreements	
Organization	Description
Maine Department of Marine Resources	Member of GOM ODP;
Maine Department of Inland Fisheries and Wildlife	Data release form
Maine Office of GIS	Have data editing agreements with some agencies (e.g., hydrography editing)
Gulf of Maine Research Institute	Project partners agree to semi-formal data publishing protocols
University of Maine, Department of Geology	One on one with agency - we collect, they manage and visa versa
University of Southern Maine	Agreement with partners to provide data on regular basis
University of Maine, School of Marine Science	Agreements with NASA, NOAA to download data from satellites
Maine Coast Heritage Trust	Not for redistribution or publication
U.S. Fish and Wildlife Service	Data exchange agreements with MassGIS and MDIFW
Island Institute	Will be developing one in next 6 months
Maine Audubon	Have policy on what may distributed to who for specific uses
Sheepscot Valley Conservation Association	Hold conservation property boundaries for other Conservation Assoc.

4.4.2 Collaborative Marine Focused Initiatives

In addition to the above-described exchange agreements, several more formal arrangements are in place with established organizations. The principal one already discussed is the Maine GeoLibrary with its many data sets available to all users. Additional collaborative arrangements are as follows. See below the chart for a definition of the acronyms. In the context of this GIS report, at present Beginning With Habitat (BWH) is primarily a user and distributor of GIS data, not a data generator. The other two initiatives, the Gulf of Maine Mapping Initiative (GOMMI) and the Gulf of Maine Ocean

Data Partnership (GOM ODP), are primarily focused on offshore data and analysis. There is at present no self-identified collaborative group focused on the nearshore region.

Existing Collaborations	
Organization	**Collaboration**
Maine Department of Marine Resources	GOM ODP, GOMMI, Beginning with Habitat
Maine Department of Conservation	Some work with BWH
Maine State Planning Office	BWH
Maine Department of Inland Fisheries and Wildlife	BWH
Maine Office of GIS	Provide some data to BWH
Gulf of Maine Ocean Observing System	GOM ODP, GOMMI
University of Maine, Department of Geology	GOMMI
University of Southern Maine	GOM ODP, GOMMI
The Nature Conservancy	BWH
Maine Coast Heritage Trust	BWH
Wells National Estuarine Research Reserve	GOM ODP, GOMMI, BWH
U.S. Fish and Wildlife Service	GOM ODP, BWH
Island Institute	Maine Coast Protection Initiative
Maine Audubon	BWH

__Beginning with Habitat__ (BWH) is a habitat-based landscape approach to assessing wildlife and plant conservation needs and opportunities. The goal of the program is to maintain sufficient habitat to support all native plant and animal species currently breeding in Maine by providing each Maine town with a collection of maps and accompanying information depicting and describing various habitats of statewide and national significance found in the town. These maps provide communities with information that can help guide conservation of valuable habitats. (from the BWH website*).*

__The Gulf of Maine Mapping Initiative__ (GOMMI) is a U.S.-Canadian partnership of government and nongovernmental organizations to conduct comprehensive seafloor imaging, mapping, and biological and geological surveys. GOMMI grew out of a mapping workshop in October 2001 that was sponsored by the Gulf of Maine Council on the Marine Environment and the National Oceanic and Atmospheric Administration. (from the GOMMI website). This group is currently focused on new mapping of the seafloor in the Gulf of Maine, not including the very near shore areas.

The __GOM Ocean Data Partnership__ (GOM ODP) was formed to promote and coordinate the sharing, linking, electronic dissemination, and use of data on the Gulf of Maine region. The nineteen research and government participants have decided that a coordinated effort is needed to enable users throughout the Gulf of Maine region and beyond to discover and put to use the vast and growing quantities of data in their respective databases. (from the GOM ODP website). This is a fairly new initiative that aims to integrate vast amounts of data into an integrated computer system that will allow visual display and analysis. Currently much of its data is offshore biologic information.

4.4.3 Data Exchange Impediments

The need for more efficient and effective data exchange is clearly one of the major issues confronting the marine GIS user community. The questionnaire asks the respondents to list what they perceive as the main impediment to efficient data exchange with other organizations. Several listed more than one impediment. The specifically identified impediments to improving data exchange are in the following chart.

Data Exchange Impediments	
Type of Impediment	Number of Organizations
Lack of clear and consistent metadata	7
Data not in a standard format	5
Effort required to create metadata	3
Lack of user knowledge	3
Hard to Find Data	2
Inaccurate and out-of-date data	2
Problem Managing large data sets	2
Politics of data access, Not sharing	2

These identified impediments match up closely with data-related answers to a question on overall GIS bottlenecks discussed in Section 4.7.

4.4.4 Web-based GIS Data and Access

The respondents were asked how they currently use the web in their GIS activities. Web technology is fast becoming a principal way to find and distribute data, metadata and applications to view and analyze GIS data. Much effort has been put into this area by many companies, and many of the interviewed organizations are deeply involved in developing these capabilities. Indeed, the main purpose of one of the organizations, GoMOOS, is to collect, archive and efficiently distribute timely weather and oceanographic data from weather buoys and other sensors via their website http://www.gomoos.org/ This website also allows efficient statistical analysis of tabular data.

Ninteen of the twenty organizations use some type of on-line GIS user interface. The most used ones are hosted by MEGIS. Other ones are developed and maintained by GoMOOS, Gulf of Maine Mapping Portal (GoMMaP), NASA, JPL, NOAA, USGS National Atlas, Northeast Consortium/UNH, and several municipal parcel level data viewers.

Use of GIS via the Web	
Organization	**Web Application**
Maine Department of Marine Resources	NOAA NOS Chartmaker, MEGIS IMS services, MassGIS & GRANIT data catalogs; Whale sighting, cod tagging, shrimp viewers
Maine DOC	MGS ArcIMS publication search site; MEGIS Ortho viewer, ftp
Maine SPO	MEGIS Orthoviewer and Wetland Characterization Sites, DMR Aquaculture IMS
MEIFW	ArcIMS
Maine Office of GIS	Orthoviewer, Basemap viewer, other in-house IMS sites
Maine DEP	DEP version of MEGIS viewer
Gulf of Maine Ocean Observing System	GoMOOS maintains a web mapping service for distributing some of the GoMOOS data and we consume various web mapping and web feature

Use of GIS via the Web	
Organization	**Web Application**
	services for some of our web based mapping products
GMRI	Cod and Haddock ArcIMS websites
UMO	MEGIS
UNE	Online maps of marine animal tagging data (http://nemo.une.edu)
USM	GMBIS, OBIS
COA	Use ArcIMS for small pilot projects
SMS	Imagery made available via: http://wavy.umeoce.maine.edu/
TNC	Use ftp to transfer data, MEGIS Orthoviewer
USFWS	GOM Watershed Habitat Analysis IMS site
WellsNERR	SWIM - Seacoast Watershed Information Manager, MEGIS and GRANIT on-line data catalogs, NOAA Coastal-change Analysis Program, MEDEP
Island Institute	MEGIS and Island Institute Lobster Tales ArcIMS site
Maine Audubon	Download data from MEGIS and other organizations. Use MEGIS Orthoviewer
SVCA	Email

There is a great variety in the purposes and focuses of these web-based GIS servers. The most used web site is MEGIS, but only about ½ of the organizations report using it. Some, like the MEGIS data catalog, allow one to research available data sets and download appropriate data for use in a local GIS program. A second type (e.g. the MEGIS Basemap Viewer and several MoMOOS viewers) allows one to compose maps based on available data. A third type is developed around a very specific application, designed for a single-purpose. An example of this would be the GIS viewer of the Northeast Regional Cod Tagging Program http://www.gmamapping.org/codmapping/ .

A developing web technology called "web services" provides a standard means of interoperating between different web-based software applications, running on a variety of platforms and/or frameworks. This allows data in one web application to be combined with another one, transparently to the user. Many of GoMOOS's applications are built upon web services. MEGIS is developing the capability to serve out the many data sets in the GeoLibrary to other web applications.

If an organization had a compatible in-house internet/intranet application, a web service connection would greatly reduce the need for an organization's GIS staff to:

- track the data sets
- determine when they have been updated or otherwise changed
- downloading and installing (replicating) them

4.4.5 Data and Metadata Standards

Only the state and federal agencies and one conservation group have declared a wholehearted commitment to the FGDC (Federal Geographic Data Committee) metadata standards for GIS data, which is the MEGIS standard. While this is much less than half of the 20 organizations, these organizations account for the great majority of the data sets

identified as developed and/or managed. FGDC is a fairly rigorous standard, but such a detailed standard is necessary for widespread and efficient distribution of the great variety of data sets produced by these organizations.

4.4.6 Needed Marine GIS Data Sets

The questionnaire asked which marine-related GIS data sets the respondents need. The following are the data sets that are identified as not currently available, or not available in a form usable by the interviewed organizations. This list is sorted by the number of requesting organizations.

Maine GIS Data Requested / Needed	
Data Set	**Number of organizations**
Detailed Inshore Bathymetry	12
Detailed Offshore Bathymetry	5
Docks, piers, wharves, marinas	4
Surficial Geology of Maine Inner Continental Shelf	4
Surficial Geology for the Gulf of Maine	4
Benthic Habitat	3
Coastal Marine Geologic Environments	3
Near Shore Trawls Surveys	3
NOAA Raster Nautical Charts (RNCs)	3
Outfalls (Stormwater)	3
Overboard Discharge	3
Feature Labels (marine place names)	3
LIDAR (elevation data)	2
Horseshoe Crab Spawning Areas	2
Public Access Sites	2
Color Digital Orthoquads	2
Dams and Barriers	2
Closed Areas (pollution)	2
Chlorophyll	2
Species Abundance	2
Circulation patterns	2
Lobster Harvest Zones	2
Shipping Lanes and Anchorages	2
Shell	2
Sea-surface Temperature	2
Conservation Lands	2
Coastal Watershed Boundaries	1
Coastal Assessment Areas	1
Essential Fish Habitat	1
Contaminants	1
Rainfall amounts	1
Marine Worms	1
Water quality classifications	1
Urchin harvest zones	1
Statistical Area Boundaries	1

Maine GIS Data Requested / Needed	
Data Set	**Number of organizations**
Species Management Areas	1
Special Areas for Protection (SAPs)	1
Shoreline Fragmentation	1
Regulatory Areas	1
Fishing Effort	1
Ports	1
Physical and chemical oceanographic data	1
Parcel-based landuse and zoning	1
Multibeam Bathymetry	1
WWTP Zones	1
Aquaculture Lease Sites	1
Land Use/Land Cover	1
Kelp	1
Seaward Boundaries for Coastal Towns	1
TOTAL: **49 unique data sets**	**101**

There is a significant need identified for Inshore and Offshore bathymetry data. Currently there are generalized bathymetry data sets available for the Maine coast, but the majority of organizations require a more accurate and detailed one for many of their needs. Other important required data sets are geology, additional habitat data and data on human uses of the shoreline (e.g. docks, piers, wharfs, marinas, outfalls). These will be discussed in the Recommendations section of this report.

4.4.7   Existing GIS Data Needing to be Updated

While a number of the following data sets are available via MEGIS and other sources, the respondents reported that many are out-of-date, incomplete or inadequate, in a difficult to use format, or simply not known about by the requester. The Coastal Marine Geological Environments, for example, are 30 years old and are based on even older aerial photography. The following data sets were identified by the study participants as likely to be in need of updates now or in the near future.

Marine Data Needing Updating	
Category	**Name**
Boundaries	Conservation Lands
Fauna	Coastal Wading Bird and Waterfowl Concentration Areas
Fauna	Invertebrate Concentrations
Fisheries	Herring Spawning Areas
Fisheries	Species Management labs
Fisheries	Species Management Areas
Flora	National Wetland Inventory
Geology	Coastal Marine Geologic Environments
Geology	Mean High Water Line
Infrastructure	Docks, piers, wharves, marinas

Marine Data Needing Updating	
Category	**Name**
Infrastructure	Public Access
Synthesis	Focus Areas of Statewide Ecological Significance
Water Quality	Outfalls
Water Quality	Overboard Discharge

4.5   Marine GIS Applications and Analysis

While the reported GIS budgets in Section 4.2.3 do not include much expenditure for GIS based analysis, in fact GIS is currently being used for many varied and valuable projects as is shown in the following chart. This is not meant to be an exhaustive list, but it gives a good summary of the many ongoing projects using and needing good quality GIS data.

GIS Analysis Currently Being Done	
Organization	**Analysis**
Maine Department of Marine Resources	Species area and volume, change analysis. Water quality analysis related to fishery regulation (shellfish closures); WWTP Impact zones
Maine Department of Conservation	Shoreline change, coastal flooding, coastal hazards, mapping coastal geology. Development of integrated MGS Beach Scoring System
Maine State Planning Office	Effects of land-based activities on near-shore environments
Maine Department of Inland Fisheries and Wildlife	Vulnerability to oil spill
Maine Department of Environmental Protection	EPA National Coastal Assessments (see: http://www.epa.gov/emap/nca/)
Gulf of Maine Ocean Observing System	Don't do analysis - fund some analysis done by others (e.g., circulation)
Gulf of Maine Research Institute	Movements, mixing, reporting rates and weighted data analyses related to cod and haddock tagging
University of Maine, Department of Geology	Offshore sand inventories, archeological and fisheries research on seafloor types
University of New England	Habitat analysis of marine animals (whales/sharks) - not limited to GOM, includes entire Atlantic. Currently bathymetry stands in for habitat
University of Southern Maine	Habitat analysis for whales and prey
College of the Atlantic	Landuse impacts on coastal environments, Whale migration and population studies, Coastal habitat change analysis, Eel grass change analysis, Biodiversity, Habitat analysis and critical habitat identification
University of Maine, School of Marine Science	Statistical analysis on time-series imagery to identify fronts, wind effect and other phenomena
The Nature Conservancy	Coastal ecology ranking to define conservation targets
Maine Coast Heritage	Aquaculture impacts on holdings (visual/noise/odor). Analysis of

GIS Analysis Currently Being Done	
Organization	**Analysis**
Trust	ecological value of potential properties.
U.S. Fish and Wildlife Service	Watershed habitat analysis
Wells National Estuarine Research Reserve	Marsh vegetation monitoring, tidal restrictions, beach/marine debris monitoring, water quality monitoring
Island Institute	Comprehensive plans for island communities, community GIS education
Maine Audubon	Shoreland habitat analysis

4.6 Future GIS Analysis

The following chart lists the many additional applications the organizations would like to expand or develop in the future if they have adequate data and other resources. Several of these listed applications are actually calls for more and/or better data sets. Others are planning to use multiple data sets to do predictive modeling of marine animal occurrence, comparing species abundance to habitat, habitat change analysis, and historical analysis of coastal development.

Planned Future Marine GIS Analysis	
Organization	**Type of Analysis**
Maine Department of Marine Resources	Historical analysis of closures, acreages of closures, analysis of WWTP inputs to coastal waters using bathymetry to calculate embayment volume, monitor activities based on bathymetry and habitat
Maine Department of Conservation	Remap CMGEs. Map shallow marine environments using multibeam and aircraft-based tools
GoMOOS	Add water quality data to circulation models
GMRI	Too busy to even contemplate this question
UMO	More detailed bathymetry and habitat mapping through multibeam
University of New England	Develop predictive models for marine animal occurrence using copepod and benthic habitat data
USM	Association of species abundance to habitat
College of the Atlantic	Coastal ecosystem sustainability
SMS	More detailed imagery would allow analysis closer to shore. More frequent imagery would allow tidal effects to be studied.
The Nature Conservancy	Identify conservation targets in the marine realm such as habitats that support sea urchins or commercial fisheries.
MCHT	Cultural aspects of fishing industry on holdings. Impacts on wildlife/nesting bird islands. Historical analysis of coastal development.
USFWS	Refining watershed habitat analysis
WellsNERR Reserve	Benthic habitat change analysis, coastal segmentation and effects of zoning on water quality
Island Institute	Same as existing analysis, but more

4.7   Bottlenecks to More Success with Maine Marine GIS

The respondents identified numerous types of limitations and bottlenecks keeping them from meeting all of their programmatic and organizational goals. These have been aggregated and summarized below:

Bottlenecks to Better Marine GIS Implementation		
Type of Bottleneck	**Summary**	**% organizations identifying this problem/issue**
Tight funding means lack of staff to develop and maintain data and little opportunity to get training needed to develop needed skill to manage and analyze data. Some organizations hardware and software is old and outdated.	Lack of Funding/Staff/Training	40%
Data that does not completely encompass a given area (e.g., Maine's coast or the Gulf of Maine). Examples include bathymetry, herring and horseshoe crab spawning areas	Incomplete Data	35%
Need to spend time researching data	Lack of Metadata	25%
Long delay between when data is collected or changes and is released/updated. Examples include NMFS survey data, closed area boundaries	Data Timeliness	20%
Need assistance to develop applications to view/analyze/distribute data. Lack of support/expertise at State level for IMS applications.	Lack of Development Support	15%
Developing complete, state or GOM-wide datasets requires long-term commitment, and for organizations to take ownership for "their" data.	Commitment to Data Acquisition	15%
Difficult to use interfaces for data download sites. Examples include MEGIS, Northeast Consortium	Poor User Interfaces	15%
Time and effort required to find and access data	Collecting Data	15%
Data with features or attributes that are inconsistent. This can be spatial (i.e., accuracy varies from location to location) or tabular (i.e., field type definitions). Examples of former include Closed shellfish areas, bathymetry, and where bathymetry and topography meet	Inconsistent Data	15%
Organizations fail/refuse to release non-sensitive data that should be made available (old boy network) Example - historical whale sightings	Data Hoarding	10%
Adding metedata is time-consuming. Format is difficult to follow. Must re-post existing metadata for use by GOM Ocean Data Partnership	Metadata	10%
Time is required to educate users about data before releasing it. Examples include fisheries abundance data	User Education	10%
Lack of standards	Data Standards	10%
Time required by organizations to prepare and organize data before distributing it. Large files sizes also make distribution difficult.	Data Distribution	10%
Data layers that represents the same information, but has slightly different features and/or attributes. Examples include: 1:24k coastlines, drainage divides, water quality sampling data	Duplicative Data	5%
Datasets can be very large and are difficult to organize and backup. Examples include imagery, sidescan sonar	Archiving and managing large datasets	5%
Lack of coordination (communication) between organizations and organizations result in duplicative efforts to create same data	Lack of Coordination/Duplicative effort	5%

Note that 12 of the 17 listed bottlenecks involve data and metadata. These are shaded in the Summary column above. The others bottlenecks are:
- lack of funding and staff
- applications needing upgrading
- lack of user education
- lack of communication between organizations

4.7.1 Ranking types of potential GIS Support

The questionnaire gave the interviewees the opportunity to rank the usefulness of various types of hypothetical support they could be given for their GIS programs. The following chart is a summary of these options. The columns have been sorted so that the leftmost column (Financial Support) is ranked the highest overall, and the rightmost one (Web Hosting) is ranked the lowest. These rankings and requests will be factored into the recommendations section of the report.

| Ranking Requested Support for GIS Activities |||||||||||||||
Name	Financial Support	Shared Planning	Training	Data Distrib Assist	GIS Stand-ards	User Group	Coord App Dev	Ad Hoc Assist	Land Based Coop	Blanket Purchase Contract	Free Software	Seminars	Web Hosting
DMR	4	4	4	5	3	2	2	3	1	3	2	1	2
DOC	5	3	3	2	2	3	4	3	2	2	4	1	2
Maine SPO	5	4	3	4	4	4	3	3	4	4	2	3	4
MEIFW	5	5	1	1	3	3	3	1	1	1	1	3	1
MEGIS	5	5	4	4	5	3	5	3	1	5	3	4	5
DEP	5	3	3	3	5	1	4	1	4	2	2	2	3
GOMOOS	5	4	4	5	5	4	3	3	3	2	3	3	2
GMRI	4	2	5	5	2	4	2	4	1	4	5	4	2
UMO	3	1	5	2	1	4	1	4	4	1	5	1	1
UNE	5	4	5	4	2	5	3	3	3	5	3	3	1
USM	5	5	3	5	5	5	5	5	5	3	3	3	3
COA	5	4	4	3	2	4	1	3	4	1	1	3	4
SMS	5	4	1	4	1	3	3	1	2	3	1	2	1
TNC	2	4	4	5	3	5	2	2	3	1	1	2	1
MCHT	5	5	5	3	5	4	4	5	4	5	5	2	1
USFWS	5	4	2	5	4	3	4	4	5	2	4	3	1
WellsNERR	5	3	5	4	3	2	5	5	3	5	4	4	4
Island Inst	5	5	4	2	3	4	3	4	4	5	5	5	4
ME Audubon	5	5	5	2	5	1	5	4	5	2	1	4	4
SVCA	5	4	5	4	5	2	4	4	4	5	5	4	4
TOTAL	93	78	75	72	68	66	66	65	61	61	60	57	50
RANK	1	2	3	4	5	6	6	7	8	8	9	10	11

5   Needs and Recommendations

5.1   Overview

Based on the research described in the previous sections, it is clear that the efficiency and quality of marine-related GIS endeavors can be improved. Challenges exist, but a focused effort by the players in the marine community to coordinate their work where practical, and to build upon ongoing efforts in the wider GIS community can lead to a real improvement even without large infusions of money. Furthermore, with additional financial and staff support, many of the bottlenecks and individual organization shortfalls can be mitigated and overcome.

The emphasis of several of the recommendations is on encouraging the marine users to work in a more coordinated manner both with each other and with the larger GIS community in Maine including the state agencies that deal with whole state, and the federal and Canadian agencies that deal with the entire Gulf of Maine, i.e. those participating in and contributing to the GOMMI, GoMOOS and GMRI projects.

It is also important for the Maine marine community to take advantage of existing opportunities and resources. Therefore some of the following recommendations are incremental in nature and utilize current resources to the extent possible. The Maine GeoLibrary and MEGIS staff has developed a true statewide GIS program. They have consolidated numerous data, software and staff expertise that form a foundation for GIS in Maine. While impetus for this came out of the public sector, MEGIS and the GeoLibrary have included a wide range of private and nongovernmental interests in their planning and activities. Many of the efforts now underway are of value to the marine GIS community, and should be taken full advantage of. The marine community should also make its presence and needs known in order to get the service it needs going forward.

5.2   Needed: Financial Assistance

The questionnaire responses in Section 4.7.1 showed that the #1 requested type of support is financial. Significant new funding has not been identified as a likely resource for marine GIS activities in the near future. However, we will recommend several ways that GIS activities can and will become more efficient going forward, which should allow for more results even without extensive additional funding. That said, marine GIS users should continue to pursue grants and other funding.

5.3   Needed: Shared Planning & Marine GIS User Group

While a user group ranked only in the middle of the types of assistance offered in Section 4.7.1, an effective marine user group would also be a good forum to advance the second and third most requested types of assistance- Shared Planning, and Training, as well as strengthen interpersonal bonds that may also lead to better ad hoc technical assistance availability from other users (another type of assistance that ranked in the middle).

One way to raise the visibility and strength of marine GIS in Maine is to form a marine GIS user group to promote the development of marine data and applications and assist its

members in the use of GIS. It could be affiliated with the Maine GIS user group (MEGUG) which meets three times a year and provides other services to its members. There could be a marine breakout session when MEGUG meets, but the marine GIS group could principally be a 'virtual' user group that communicates electronically.

A recognized marine group would give the marine users potentially more clout within the Maine GIS user community. This should lead to influence on broad policy issues, such as the specifications for new base map development and potential other data and GIS infrastructure projects, and ensure that the unique needs of marine users are not ignored or overlooked. Everyone is busy, but a user group does not have to be elaborate or particularly time-consuming.

5.3.1 Marine GIS User sub-groups

Geographically and culturally the 20 organizations interviewed for this needs assessment have greatly different organizational and programmatic goals. They split along several planes:
- Their type of organization as used as a differentiator in this report (state, academic, research, land trust, federal, conservation)
- Government vs. Private
- Science vs. Policy
- Large vs. Small

However, perhaps the most useful differentiator may be their principal geographic area of interest- near-shore vs. Gulf of Maine. This is because of two related factors:

- the type of data that has been and is currently generated for these areas has very little overlap
- the focus of interviewed marine organizations is generally on one area or the other.

While the ultimate goal of GIS is to have integrated data sets that enable work on a large regional basis, e.g. the entire Gulf of Maine, in the short term more data and application coordinated goals can be pursued and accomplished towards that long term aim.

Therefore the recommendation is to think in terms of 2 subgroups, one with a nearshore focus and one for offshore marine interests. While this may appear to dilute the marine focus, in fact it allows each group to sharpen their focus onto the issues they each are most interested. While there are data overlaps between nearshore and offshore (e.g. fisheries studies and geology), there is currently not extensive overlap in the projects or data required by the near-shore and offshore focused groups. The goal here would be to expand the merging of data sets and applications over time, and ultimately have relatively seamless data from inland Maine to its offshore borders and beyond into the full Gulf of Maine.

5.3.2 Nearshore Marine Mapping Subgroup

The subgroup of those focused on the near-shore marine environment should be self-selected, but probably includes all of the groups interviewed for this study with the exception of GoMOOS, and most of the academic research groups, (excepting COA, which has a history of nearshore GIS activities). This subgroup has several needs that most of them are concerned with:

- Nearshore data sets including natural resources, human use, and pollution data
- Onshore data on property ownership, conservation lands and other land uses
- Watershed characteristics as it may affect the marine environment
- Identification of areas to conserve and protect
- Coastal morphology and ecology
- Better integrating data and applications with the land-based organizations and their GIS and mapping activities.

It is obvious that the shoreline and near-shore marine environment is a zone of transition between the land and the sea, and this has also been the case in terms of mapping and data gathering over a long period of time. From the first time accurate maps were made, with the possible exception of some DesBarre charting from the late 18th century and the US C&GS charts of the late 19th and early 20th centuries, most maps have been compiled to focus either on the land or the near shore environment or, less frequently, on the open sea.

The map projections have been different, the definitions of the shorelines they have used are quite different, i.e. whether the datum is based on mean high water (MHW) or low low water (LLW) or other datums. It has been left to individual users of these resources to bring the information together when needed. Add to this the changeable nature of the marine environment and the different dates when the data were compiled and the integration of these data resources is a complex and nuanced issue. GIS can 'theoretically easily' bring any of the geographic data sets together, but to do it in a coherent and planned way is a significant challenge.

The new orthophotography will partially bridge the divide, but it was not flown to consciously capture low tide, or to extend far enough into the ocean to cover all shallow and near-shore areas (DMR does have some imagery flown in synch with low tide).

5.3.3 Offshore Marine Mapping Subgroup

As shown in the first part of this study, offshore focused programs are excellent at gathering and analyzing accurate and scientific data sets of the geology, biology, habitat, atmosphere, and marine water column. They do this primarily with remote sensors and sampling techniques.

What is missing from the group of 20 that were interviewed for this study are those mainly federal groups that plan the global sensors and data development exemplified by the vast data being gathered into the GoMOOS website and the GOMMI efforts to

coordinate and find funding to advance multibeam seafloor mapping. However, the groups that were interviewed are very cognizant of these activities and are well positioned to keep the near-shore groups apprised of trends and activities. They are also likely to be early adopters of GeoPortal technology as a way of efficiently using data sets from multiple sources without having to replicate them on their own networks.

5.4 Needed: Better Data Distribution

The fourth most requested type of assistance is data distribution. The heart of the Maine GeoLibrary is its warehousing of GIS data sets to provide internet-based cost-free access to the data by all users (government, NGOs and the public). While MEGIS has allowed searching and downloading of data sets for some time, the Geolibrary is implementing a "GeoPortal" which extends and standardizes this capability within standards established by the Open Geospatial Consortium (OGC). The new system will allow for extended search capability, including direct connection to other OGC compliant portals so that those repositories, including NOAA, other federal agencies and GeoConnections (which is developing Canada's Geospatial Data Infrastructure) can be searched. Also built into the portal design is the ability to directly view data sets from multiple portals within a browser session. This is the 'web services' described in Section 4.4.4. While this technology is still being implemented, it points to the potential for the Maine marine GIS community to much more effectively find and use GIS data for their required applications. As this technology matures over the next few years, the marine community will have the choice of loading data sets into the GeoLibrary portal, other OGC portals. All this capability presupposes data and metadata standards.

Many of the data sets currently being used by most of the 20 marine organizations and others are currently within the GeoLibrary warehouse, and additional data of general interest produced in the future should also be formatted for inclusion in the GeoLibrary or other data portal. This would help the user community in two ways- the data producer could point data requesters to the GeoLibrary rather than having to take the time and make the effort to respond to individual requests for the data. Also, if good data is in the GeoLibrary, others can more easily find it and include its information in their studies.

The current system is not perfect. It has limited funding, and is still under development. Some data is awkward to use for large areas, as it is currently stored as relatively small tiles. Some user find the metadata requirements daunting and this inhibits them submitting good data sets for inclusion in the GeoLibrary where they could benefit many users. However, the state has made a major commitment to this infrastructure, and it is recommended that they be engaged by the marine community of users and strongly encouraged to provide the services they need. Once data is loaded into this system, it will be much easier to access and distribute via simple internet downloading.

The Maine GeoLibrary is set up to archive "out-of-date" data sets in conjunction with the MEGIS data warehouse. This resource will, over time, become more and more important to many marine applications that need to quantify change in the human use of coastal areas and watersheds.

5.5   Needed: Data and Metadata Standards

The fifth most requested type of assistance is with data standards. The GeoLibrary has adopted several types of standards for GIS related data and metadata. The primary documentation standards are the Federal Geographic Data Committee (FGDC) standards for metadata creation and management, and the MEGIS data standards http://apollo.ogis.state.me.us/standards which are focused on the accurate map compilation and automation.

FGDC compliant metadata is a requirement for data sets to be included in the GeoLibrary. The FGDC metadata standards focus on proper and full documentation of GIS data sets to allow users to rapidly understand the strengths and weaknesses of existing data as they evaluate it for relevance within their own applications. Data and metadata issues dominated the list of bottlenecks in Section 4.7. as well as the list of data exchange impediments in Section 4.4.3. Ironically there are many complaints both about how hard it is to create metadata and complaints that incomplete metadata makes it difficult to understand and appropriately use data. Data development is very expensive and time-consuming and unless there are security or confidentially issues, the data should be made available to the wider GIS community in a manner that is easy to use. Marine GIS users must make the effort to rectify this situation by finding time to create metadata for marine data that they produce.

Software such as ESRI's ArcCatalog and Intergraph's Spatial Metadata management System (SMMS) and Metavist are designed to produce FGDC compliant metadata. Many marine users use ArcGIS, which includes ArcCatalog. It can create some of the fields of FGDC compliant metadata relatively easily, but the users need to add additional data to be fully compliant. If the user community can reduce the level of effort needed to find and distribute GIS data, it will have more time for new data development, marine focused applications and other initiatives.

MEGIS staff Kate King is ready and willing to assist in the review of GIS data sets, review of metadata and installation of data in the Maine GeoLibrary. This and other MEGIS staff expertise should be utilized when needed, in a responsible way. Maine DMR would likely be in a good position to assist if the organization developing the data were without much experience in this type of transaction and the data were judged to be of value to the marine user community.

While MEGIS has always offered a limited amount of no-cost technical assistance to state agencies and affiliated group, it relied on fee-based MOUs for additional and larger projects. There is a plan in place to change this to a system built into the Maine Office of Information Technology assessment. Depending on how this moves forward, MEGIS may have added capacity to provide technical assistance to its user community.

5.6   Needed: Outreach and Education

MEGIS provides some outreach and education. Their website has extensive information on GIS theory and practice, available data and metadata, links to other GIS users, including many focused on marine issues, trouble shooting tips for hardware and

software problems, etc. In addition staff is available to answer specific queries. Marine users should take advantage of MEGIS resources; it is a solid and still developing asset for the state and its many GIS activities. The marine GIS community should work with MEGIS to get the services they require.

5.7 Needed: Marine Data

MEGIS and the larger GIS user community have prioritized production of several data sets also of great interest to the marine organizations interviewed. The user community should keep up-to-date on these projects and use the data when it is available. These include:

- up-to-date orthophotography base map managed by MEGIS - southern coastal Maine is complete (2001 imagery) and the remaining coastal areas are scheduled to be delivered by late Fall 2006. This is excellent color imagery- 1' pixels in the South and 2' pixels further down east. Existing samples show some features underwater and visibility in shallow waters should add to its utility for the near-shore marine users. While the extent of the imagery below the shoreline might not be adequate in all locations, this will be a good new source as a base map and for facilitating the compilation of visible features into vector data sets (e.g. docks, piers and wharfs).

- land parcels- there is an active program underway with the GeoLibrary board distributing $366,000 to over 70 communities to enable them to produce GIS parcel data to a common standard. Parcel automation and attribute standards were established and data is being funded and gathered on a town-by-town basis. The common production and data standards are key for organizations to efficiently and seamlessly use parcel data from multiple communities in their mapping applications.

- A data set not identified by the organizations interviewed, that would be very useful for some applications are detailed layers of land hydrography and watershed boundaries. There is currently a statewide data set available and USGS is nearing completion of an updated data set.

As noted above, new software, data and metadata standards and tools, and general data viewers will continue to come from the greater GIS community, but marine data sets will only come from those requiring the data, i.e. the marine GIS user community. The following data sets are of high priority the Maine marine GIS community as identified in Section 4.4.6:

- By far the most requested (Section 4.4.6) and by far most expensive data set to produce would be detailed near-shore bathymetry created by multibeam sonar. This is a core marine 'base map' equivalent to topography on land, without which thematic data sets such as flora, fauna and geology are not 'pinned down' to an accurate vertical base reference.

Numerous projects have created detailed bathymetry for small areas of the Maine coast. Organizations doing this include NOAA, UNH and Woods Hole Oceanographic. Current US Army Corps of Engineer standards call for horizontal and vertical accuracy standards to be more accurate than the current MEGIS 24:000 USGS land basemap, e.g. 1' vertical and 6' to 16' horizontal accuracy in less that 15' of water, although a project of this extent would need to develop its own standards. Production of this data would be an excellent long-term project/goal for the marine user group, perhaps led by DMR, to plan and build over the long term. The pricing for this data set is not possible to predict without extensive research beyond the scope of this study.

The existing NOAA nautical charts are being vectorized by NOAA. Creating a bathymetric data set from this would be easy to accomplish, but also be significantly less accurate and detailed than the multibeam data described above. The harbors have larger scale manuscript maps (e.g. 1:5,000; 1:10,000; and 1:20,000), but less populated and used parts of the coast are at 1:40,000 and 1:80,000, which is a very small scale. It would take a staff person on the order of 6 months to take the vectorized data and create a statewide data set from it. A private vendor might charge $40,000 to $60,000 for the work. It is possible that a vendor will create it as a product and license it to the state for a much lower cost, and this should be explored.

- The Coastal Marine Geologic Map series show the locations of over 50 types marine and on-shore environment types, e.g. mud flats, beaches, salt marshes, etc. These maps are used extensively, but are out of date, having been originally published in 1976 and 1977 and subsequently digitized. The Maine Geological Survey created them originally. The series is in need of an extensive revision. The cost of this has not been estimated.

- Benthic habitat data exists on a very limited basis. Some of the basic research has been done with the Maine Geologic Survey's sidescan sonar for some of the coast which reveals bottom type. This project would build upon near-shore bathymetry data when and it is collected. There is an existing Gulf of Maine benthic point data set that has been adopted as the current standard. R. P. Signell is the principal creator of it. It is an excellent product compiled and created from many manuscripts and research projects. The one complaint is that the depth points are generalized to a ½ kilometer gric, which is adequate for Guld wide studies but not larger scale projects. Some offshore researchers would like a more detailed representation of the benthic surface. An estimate of the cost of upgrading this data sets has not been made for this study.

- Some existing data is available for docks, piers and wharfs. The DEP has, for about 5 years, collected a database of dock and wharf permits. In addition, The Island Institute is compiling data on public and commercial docks, piers, wharfs and related rights-of-way. They say that about 90% of communities are cooperating in this survey. In addition, the new state orthophotography is clear

enough to see these structures. It is estimated that a project to pull all this information together into a GIS point data set would take approximately ½ a person year, assuming the Island Institute survey was completed for the participating communities.

5.8   Needed: Hardware, Software and Applications

Some organizations noted that their hardware (computers, plotters, and other peripherals) were out of date, but the interviewees did not highly rate the need for assistance with blanket purchases of hardware or software. ESRI does have software blanket purchase agreements with the state agencies, the university system

Much of the need for GIS applications can be met with basic GIS software and the growing number of simple, robust data viewer applications, more and more of which are based on web browser technology. As discussed in Section 4.4.4, there is great effort in the GIS community being put into web-based applications and web services, and the marine GIS users will be able to benefit from these developments at MEGIS, federal agencies and user groups, and from vendors such as ESRI and Google. Marine users, especially from smaller organizations, will be able to largely piggyback on these developments rather than spending the time learning to develop their own user interfaces for simple data viewing and map creation.

That said, if an organization has a specific need for an application with unique capabilities and/or sophisticated analysis, these applications currently should be developed on desktop GIS systems. If the application is also of general interest outside of the organization a customized browser can be the best method of making the information available. An excellent example of this is the ArcIMS based Northeast Regional Cod Tagging Program http://www.gmamapping.org/codmapping/ described in Section 4.4.4.

5.9   DMR coordination role

DMR has funded this study. We believe it clearly demonstrates that a focused, coordinated effort is required to significantly advance the quality and capabilities of marine mapping in Maine. As the state agency primarily involved with the Maine marine environment, DMR is well positioned to take a leadership role in coordinating and promulgating marine GIS activities. In addition to promoting the recommendations made herein, the following tasks would be basic to this role:

- Be a core driver of the recommended marine user group
- Advocating needs of the marine GIS community to MEGIS, GIS Executive Council and Maine GeoLibrary
- Provide outreach and education to the marine GIS community, advising them on:
    o existing and planned data and data analysis resources
    o getting new data collected in a standard manner
    o assist in getting important new data sets funded, produced, documented and installed in GeoLibrary which gives the user community ready access
    o providing ad hoc technical assistance to marine users
    o provide or notify about workshops and training opportunities

- Maintain and update the Access database created as part of this report
- Support ongoing email/web page/wiki communications highlighting data, application, and staffing issues and decisions among marine users and related other groups, include information on any marine user group initiatives

Appendix A – Survey Form

Appendix B - Survey Participants

ORGANIZATION	NAME
Maine Department of Marine Resources	Seth Barker
Maine Department of Marine Resources	John Fendl
Maine Department of Marine Resources	Carl Wilson
Maine Office of GIS	Dave Kirouac
Maine Department of Environmental Protection	Steve Harmon
Maine State Planning Office	Liz Hertz
Maine State Planning Office	Janet Parker
Maine Department of Conservation	Steve Dickson
Maine Department of Inland Fisheries and Wildlife	Don Katnik
Gulf of Maine Research Institute	Shelly Tallack
Gulf of Maine Ocean Observing System	Tom Shyka
University of Maine, Department of Geology	Joseph Kelley
University of Maine, School of Marine Science	Andy Thomas
University of New England	Stephan Zeeman
University of Southern Maine	Matthew Bampton
University of Southern Maine	Nick Wolff
College of the Atlantic	Gordon Longsworth
The Nature Conservancy	Dan Coker
Maine Coast Heritage Trust	Megan Shore
Maine Coast Heritage Trust	Christina Epperson
U.S. Fish and Wildlife Service	Bob Houston
Wells National Estuarine Research Reserve	Susan Smith
Wells National Estuarine Research Reserve	Megan Tyrrell
Maine Audubon	Barbara Charry
Sheepscot Valley Conservation Association	Maureen & Paul Hoffman
Island Institute	Shey Veditz